Transactionality of Digital Transformation within an R&D Organization

Mars Khasanov, Fedor Krasnov

Abstract — More than 70% of projects within organizations fail for two main reasons: inadequate implementation of changes, and insufficient development of the idea behind the project. However, changes are indispensable, and usually there is no time to wait. The authors have considered the relationship between the most common problems faced by the organization and their causes. We also identified the differences in the functional and engineering style of the management of change (MOC) process. We gave definitions of the "black box" and "white box" in the way of thinking about the organizational system undergoing transformation. We examined the system contours of interaction in the course of digital transformation and showed the generic features that affect the success of changes made in the organization. We reviewed the level of understanding of the digital transformation outcome. The quintessence of the authors' reasoning can be formulated in the following maxim: "The requirement to show quick results from digital transformation entails the need to make a complete rollback to the initial condition before the changes had been made." Further, the authors showed why the ability to roll back changes ("transactionality") associated with digital transformation plays a key role for its successful implementation.

***Keywords* — Digital transformation, R&D effectiveness, change management, organizational design.**

"... Experience, the son of painful errors..." – Alexander Pushkin

Steve Jobs: "If you're afraid of failing, you won't get very far"

I. Discussion

The term *digital transformation* mostly reflects the present time, while in the early 20^{th} century the similar process could be called *electrical transformation*. Back then, the greatest expectations of progress were associated with electrification of the industries, just like digitalization today.

According to the study performed by IDC[1], there are five stages of digital transformation within a company, which are expressed in changes made to business models by means of digital competences.

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At the first stage, which is called "unsystematic", there are companies that "resist digital transformation". Their digital initiatives are fragmented, inconsistent with the corporate strategy and not focused on interaction with the customer; as a result, their business development is sluggish, and they use digital technologies only to counter threats.

The second stage of "looking for opportunities" is the place for "explorers of digital technologies". Such companies have already perceived the need for a digital business strategy focused on the customer, but so far this strategy is implemented at the level of individual projects. Their progress is unpredictable and irreproducible. Digital-based customer interactions and products resulting from their efforts are haphazard and poorly integrated.

The third stage of "reproducible results" is occupied by "digital players". Their business and IT activities are coordinated across the company and aim to develop digital products and interactions with customers, but are not yet intended to untap the revolutionary potential of digital initiatives. The result of these activities is that the company offers digital products, services and customer interactions which are not innovative though.

The fourth stage, "controlled", belongs to "reformers". Thanks to well-coordinated and integrated business and IT management, the company offers products and services based on digital technologies. As a result, the company becomes a market leader, working at the level of world-class standards.

The highest, "optimized" stage is occupied by "digital revolutionaries". By actively using the latest digital technologies and business models, the company shapes up the market. The company's knowledge of the ecosystem, and customer feedback continuously bring new data to update the business. The result is that the company is changing existing markets and creating new ones to its advantage; competing with the company is very difficult as it is a moving target.

Five stages of maturity is a fairly common maturity model. For instance, in the software development processes the authors made extensive use [4] of the CMMi[2] five-staged model. The authors' practical experience in the application of five-stage maturity models showed that the organization should not and cannot be considered as being at one and the same stage of transformation entirely. The organization needs to be divided into subdivisions that should be considered as being at different stages of maturity. But even such division is not always consistent because even within one subdivision, as a result of group dynamics,

[1] https://www.idc.com/getdoc.jsp?containerId=US43220117

[2] https://cmmiinstitute.com/

there may be further divisions into work groups of different degrees of maturity. Such heterogeneity makes it necessary to form business units with equally high maturity levels. For scientific teams of oil companies, historically such units were made up of reservoir engineers working on development projects associated with the most knowledge-intensive processes having the biggest effect on field development engineering. Thus, it gave rise to scientific engineering units built up as most mature in terms of the five-step maturity model applied to the company.

Let us now examine the problems faced by the scientific engineering unit within an organization in the course of digital transformation [5]:

- complexity of the organization has become unmanageable;
- complexity of IT applications has become unmanageable;
- the IT application portfolio does not have any clear definition and route forward;
- IT applications fail to solve their tasks;
- business architecture is the weakest point in the entire architecture of the organization, and all other elements are inherited from it.

The authors' experience in analyzing the problems of organizations shows that the root causes of the problems are:

1. Inefficiency of the information systems science; low level of professionalism in meeting business needs;
2. Inefficiency of the organization management science; use of management approach (functional approach) instead of engineering approach (constructive approach).

Let us consider in more detail what the authors mean by the "engineering approach" on the example of the "black box" and "white box" (Figure 1).

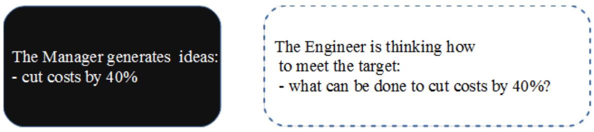

Figure 1: "Black Box" and "White Box".

The "black box" way of thinking focuses on input parameters, transformation functions, and output parameters. In this way of thinking, a car as a system can be functionally decomposed into a lighting subsystem, a brake subsystem, a sound subsystem, a control subsystem, etc.

On the other hand, the engineering approach presents a system as a structural composition, or a "white box". A car from the engineering standpoint is the wheels, the engine, the radio, the air conditioning, the brakes, etc.

Note the obvious convenience of the "white box" way of thinking for transformation of a system, since on the one hand the system is presented as a whole, and on the other hand each of its constructive components remains functional.

In order to delve into the subject and understand the concept better, we should clarify what we mean by the "system". In case of an organization, it is not so obvious as in the example with a car. If the organization is large, everything in it is complex; so let us consider the concept of "complexity" more closely.

In the complexity/occasionality coordinates, the organization stands in the middle. The extreme positions in these coordinates are held by insect populations (which are not organized and completely occasional), and clockworks (which are highly organized and non-occasional). Standing in the middle, organizations are not so occasional to be described by statistical methods but may be too complex to be analyzed by algorithmic methods. The primitiveness of the approaches based on the *Work Flow* and *Business Process Management* concepts showed everyone that organizations' activities can be algorithmized for a narrow class of processes only. For example, the so-called *end-to-end processes*. Therefore, we can talk about organizations as "organized complexity".

Now we can consider the concept of *engineering organization* as a whole or within a single business unit, for instance, scientific engineering units within the Science and Technology Center.

In his papers [1, 2] Dmitry Namiot considers digital transformation as a transition to "smart working". The key role in digital transformation is played by people and IT systems. It is important to note therefore that the digital organization should be looked at as a result of digital transformation. It implies, in particular, that considering a digital organization as a "black box" consisting of people and IT systems inherits all the above limitations of this way of thinking.

An important aspect of digital transformation is transactionality. Thinking of each atomic organizational change as a transaction, the authors have identified such important properties of transactions as completeness and reversibility.

The first lines of this study mentioned the two of the most popular reasons for failure of projects: inadequate implementation of changes, and insufficient development of the idea. Keeping this in mind, the authors are convinced that the key to increasing the share of successful projects is to complete the changes by all means, and to provide for the possibility to roll the changes back to the initial state.

No one knows in advance if this or that approach to digital transformation will be successful or not [6]. Many professionals believe that trying to blindly reproduce techniques that proved to be successful for some organizations is quite risky and short-sighted practice.

It is only the scientific approach to changes that gives the most predictable result. The basis for the scientific approach is the formulation of a hypothesis and its subsequent verification by practice. But this approach should also provide for the possibility to start from the initial state by rolling back all the changes made. That is, to use one of the main properties of changes: their transactionality.

The traditional transaction layout connects the customer and the contractor with the two circuits:

1. Customer – *Request* – *Commitment* – Contractor;
2. Contractor – *Fulfillment* – *Acceptance* – Customer.

In these two circuits, the following communication artifacts appear: the fact of sending a request, the fact of *commitment* to fulfill the request, the fact of fulfilling the request, the fact of accepting the result of the fulfillment.

On the basis of these facts, the transactional discipline of the engineering organization is built. The concept of “discipline” is inextricably linked to the organization’s architecture and ontology. Conceptually, the organization’s architecture is a set of limitations (the discipline) in “creativity”. And in practical terms, the organization’s architecture is a consistent and holistic set of principles that set the direction for transformation. For simplicity, we can draw an analogy with the architectural ensemble of the city which regulates all future changes and rejects foreign elements.

In turn, the organization’s ontology conceptually gives understanding of the organization’s design and operation, regardless of its transformation [3] while in practical terms the organization’s ontology is a model of the organization at the highest level, which also sets the direction for transformation. Unlike the architecture, the organization’s ontology limits creativity “from the bottom”. Using the same analogy with the city, the ontology determines the list of building materials to be used: concrete blocks, bricks, etc.

Qualitative aspects of the organizational ontology meet the C_4E quality requirements:

1. Coherent: all parts of the model represent a single whole;
2. Consistent: no logical inconsistencies;
3. Comprehensive: the model contains all the necessary elements;
4. Concise: the minimum required size;
5. Essential: independence from a particular implementation.

Now, having comprehended the two components of digital transformation – efficiency of the organization and efficiency of the IT, we may consider the third component – creativity.

Capability of an individual human mind, without external support, is greatly exaggerated. Most of a person’s creativity has social roots, as it results from activities performed in the social context, in the course of a person’s interaction with other people and IT systems where the collective mind is embodied. According to the research by G. Fisher [7, 10, 11] and his followers [8, 9], social creativity is not a luxury but a necessity caused by the problems faced by people in the XXI century, for example, digital transformation. Thus, the organizational environment (departments, offices) is a necessary component required to perform the tasks of digital transformation.

Returning to the problems of organizations rooted in the inefficiency of the organization and IT system sciences, it becomes logical to motivate the formation of business units with high creativity of their members responsible for scientific engineering, which is the engine of digital transformation.

II. Conclusion

The laws of the digital economy are inexorable and apply to all participants in the process. According to IDC forecasts, by 2019 a third of the companies that are now among the top 20 in most industries will start facing serious competition from new players and restructured old-timers who use the 3.0 platform to create new services and business models. In addition to rapid changes in technology, other factors that will have a strong impact on the market will include geopolitical, economic and environmental issues some of which can be predicted and some of which not, analysts believe. Yet, the essence of systems thinking is not to track linear chains of causes and effects but to see the relationships and have a clear vision of the whole process of change in its entirety.

The systems approach postulates that it is impossible to reduce scientific disciplines to a single basis. The world needs to be described in a multi-disciplinary, “multi-scientific” way. Simple interactions of parts of a system may lead to the emergence of completely new effects. None of the parts of an aircraft contains the flight function. Only if fully assembled, your wrist watch carries the concept of time, but none of its gears separately. Just like that, the geoscience can not be reduced to an understanding of production, geology and development. The key to understanding the system is not in its parts but in the new essence that appears when they interact.

The challenge for the scientific engineering is to combine traditional sciences with organizational sciences, and apply the knowledge of information systems basing on the principles of organizational ontology and architecture. By meeting this challenge, we may create something new that digital transformation of the organization will lead us to.

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Транзакционность цифровой трансформации в научно-технической организации

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Аннотация — **Квинтэссенция рассуждений авторов может быть сформулирована в виде следующей максимы: «Обязанность показывать быстрые результаты от цифровой трансформации содержит в себе необходимость производить полный откат изменений к исходному состоянию». Далее авторы показали почему возможность откатить изменения (транзакционность) связанные с цифровой трансформацией играет ключевую роль для успешного её завершения. Более 70% проектов внутри организаций терпят неудачу по двум основным причинам: неадекватное внедрение изменений и непроработанность идеи. Но изменения нужны и обычно нет возможности ждать. Авторы рассмотрели связь наиболее распространённых проблем организации с причинами их вызывающими. Определили различия в функциональном и инженерном стиле управления изменениями. Дали определения «чёрного» и «белого ящика» в стиле мышления по отношению к трансформируемой организационной системе. Рассмотрели системные контуры взаимодействия в ходе цифровой трансформации и показали их родовые особенности, влияющие на успех проводимых в организации изменений. Рассмотрели понимание результата цифровой трансформации.**

Ключевые слова — **Цифровая трансформация, эффективность НИОКР, управление изменениями, организационный дизайн.**